

A.1.5 ASTRONOMY AND PHYSICS RESEARCH AND ANALYSIS

1. Scope of Program

1.1 Overview

The Astronomy and Physics Research and Analysis (APRA) program solicits basic research proposals for investigations that are relevant to NASA's programs in astronomy and astrophysics. The applicable wavelength region for proposals is essentially the entire electromagnetic spectrum, from radio to gamma rays, and the gravitational wave spectrum below approximately 1 Hz. In addition this program supports research relevant to space-based investigations in particle astrophysics, gravitational physics, and tests of the fundamental laws of physics. In the area of experimental particle astrophysics this element supports studies related to understanding the origin, acceleration, and transport of galactic cosmic rays (all particle species). Fundamental measurements include the elemental abundance, isotopic composition, and energy spectra of galactic cosmic rays, as well as antimatter, exotic particles, and dark matter to provide tests of theoretical models.

This program element has four primary goals: (i) to develop detectors that represent the best possible state-of-the-art detector technology for instruments that may be proposed as candidate experiments for future space flight opportunities; (ii) to develop science investigations whose completion involves the flight of instruments as payloads on suborbital sounding rockets or stratospheric balloons; (iii) to develop supporting technology, perform laboratory research, and/or conduct ground based observations (see below for restrictions) that are directly applicable to space astrophysics missions; and (iv) to investigate topics in gravitational wave astrophysics and space tests of fundamental physical laws (including relativity).

While excellence of proposed research is the primary selection criterion, relevance to the goals of the Astronomy and Physics Division, including flight missions and overall science objectives, is a necessary criterion and must be explicitly described in the proposal. As a guide to assessing relevance of proposals for this Program Element, prospective proposers may find links to past, present, and future missions, the OSS Strategic Plan, and the SEU and ASO Roadmaps via the OSS home page at <http://space.science.nasa.gov>.

Finally, note that to enable the NASA Office of Space Science to evaluate properly the relevance of proposals submitted to its programs, as well as to track its progress towards achieving its goals as mandated by the Government Performance Review Act (GPRA), all research supported by NASA's programs must demonstrate its relationship to NASA Goals and Research Focus Area's (RFA's) as stated in the latest version of its Strategic Plan (follow links from the Web site <http://space.science.nasa.gov/>); see also the discussion in Section 1 of the Summary of Solicitation of this NRA. Therefore, all proposers to this program element are asked to state their perception of this relevance in terms of the Goals, Science Objectives, and RFA's given in Table 3 found in the Summary of Solicitation. In particular, this program

element is designed to help fulfill any of the RFA's for all of the Science Objectives for Goal II of both the science theme "Astronomical Search for Origins" and "Structure and Evolution of the Universe." The appropriate place for this statement of relevancy is in the introduction to the proposal's "Scientific/Technical/Management" section (see Section 2.3.5 in the Guidebook for Proposers). The index numbers in this table may be used to identify a specific RFA, for example, "Goal I, Sun-Earth Connection Theme, RFA 1(c)" or "Goal II, Astronomical Search for Origins, RFA 3(b)."

1.2 Special Considerations

- The Laboratory Astrophysics component of the APRA program includes theoretical investigations in the area of Atomic and Molecular Astrophysics. All other theoretical investigations are solicited separately under the Astrophysical Theory program discussed in Section A.1.4 of this NRA.
- Projects directed mainly toward the analysis of archival data are solicited under the Astrophysics Data Analysis program discussed in Section A.1.2 of this NRA.
- Investigators proposing standalone detector development should propose to the Detector Development category. Proposals where detector development is integrated into a suborbital program should be submitted to the Suborbital category.
- Ground-based particle observations are not supported by this program element. Other projects for ground based observations will be considered only if they are in direct support of NASA space astrophysics goals, and the proposers are ineligible by virtue of their institutional affiliation to receive direct support from the National Science Foundation for ground based astronomy (see below for exception).
- Ground based proposals in support of rapid searches for counterparts to Gamma-ray Bursts may be submitted by all investigators, including those who are eligible to receive direct support from the National Science Foundation for ground based astronomy.

Topics of interest to this APRA program fall into the following research categories:

- Detector development – see below for further details.
- Suborbital – supports programs that require balloons, sounding rockets, or similar-class payloads flown as flights of opportunity; see further below for further details.
- Supporting technology studies – for example, ultra-light holographic/diffraction grating development, thin films, lightweight composite mirrors, spectrometers, interferometers, and infrared cameras.
- Laboratory astrophysics (theoretical or experimental for all wavelengths) – for example, predissociation in diatomic molecules, electron-ion collisions, compilation of transition probability data, measurement of absolute oscillator strengths, spectroscopic studies of PAH's, investigation of carbon clusters, and computation of atomic or molecular parameters.
- Gravitational wave astrophysics and space tests of fundamental physical laws (including relativity) – for example, lunar-laser ranging tests of relativity, low frequency

gravitational wave astronomy, frame-dragging, geodetic precession, and violations of the equivalence principle.

- Ground-based astronomy – for example, calibration of supergiants for Hubble Space Telescope, rapid searches for counterparts to Gamma-ray Bursts, and the development of instrumental or observing techniques.

- Detector Development

Investigations are solicited in the area of detector development that advance the understanding of the fundamental operational aspects of detectors, as well as proposals to develop new types of detectors to the point where they can be proposed as part of instruments in response to future announcements of flight opportunities. Although any detector technology may be proposed to this opportunity, the James Webb Space Telescope (JWST) project is currently actively supporting detector programs for that mission; therefore, proposals in response to this current NRA for developing detectors specifically to achieve JWST detector sensitivity or performance goals will be given a lower priority.

Considering the currently available technologies for detectors for space astronomy, the greatest emphasis of this solicitation will be for those proposals that address the technological problems associated with achieving some of the following desirable detector attributes (neither in priority order nor all inclusive):

- Increasing quantum efficiency;
- Increasing the array format size;
- Increasing the spatial resolution;
- Increasing the dynamic range (including individual detector elements, as well as the collective response of the detector);
- Developing high speed, high resolution, low noise read-out techniques;
- Reducing detector noise;
- Fabrication and formatting techniques;
- Extending wavelength coverage (e.g., operation of submillimeter and radio receivers at high frequency, increasing instantaneous bandwidth, extending mid-IR detectors to operate either passively or cooled at longer wavelengths, or near-IR detectors to shorter wavelengths);
- Developing resistance to effects of operation in space;
- Developing novel particle identification techniques; and
- Improving x-ray calorimetry.

Since the environment and constraints of space flight are far stricter than those for ground-based applications, research groups considering development of space detectors must be cognizant of the following characteristics that are highly desirable in reliable, space-quality detection systems: low mass, low sensitivity to particle radiation (i.e., "radiation hardness"), low power

consumption, compactness, operation in a vacuum (such that high voltage arcing is minimized), vibration tolerance, ease and robustness of integration with instrumentation, and ease of remote operation, including reduced transient effects and ease of calibration.

New measurement concepts may be proposed, as well as methods to improve the performance of existing detectors. Proposed research must address detector systems that could be considered for use in space (note: this program does not support development of detectors that are primarily intended for ground-based astronomy). However, it is understood that observing with ground-based facilities outside the laboratory for newly-developed detectors may be necessary to verify detector or overall system performance; if such an activity is proposed as an integral part of a detector development program, this case must be made clear in the proposal. Finally, proposers are encouraged to identify potential mechanisms that could facilitate transfer of these detector technologies to other users, including the private sector, for possible application beyond the immediate detector development goals for NASA's programs.

- Suborbital Program

The purpose of the Suborbital Program is to provide opportunities for development of science investigations and/or technology development utilizing payloads flown on sounding rockets or balloons, or as space flights of opportunity. A discussion of the plans for management and for reduction and analysis of the data should be given. Although most awards are for three years duration, in rare cases a five year proposal may be accepted to develop a completely new, highly meritorious mission through its first flight.

Budgets are expected to cover complete investigations, including payload development and construction, instrument calibration, launch, and data analysis. The number of groups that can be supported is limited and heavily dependent on the funds available to this program. NASA does not carry reserves to accommodate any cost overrun incurred by a particular investigation. Such a situation may entail either descoping the initially proposed investigation, delaying it, or canceling a particular launch date opportunity.

2. Programmatic Information

2.1 General Information

It is expected that roughly \$12.0M will be available through this NRA for the funding of new projects among the categories listed above: detector development, suborbital investigations, supporting technology, laboratory astrophysics, gravitation and fundamental physics, and ground-based astronomy. Of this \$12.0M, approximate half will be focused on high-energy astrophysics programs covering x-rays, gamma rays, and particle astrophysics. Investigators may propose programs of any size for funding extending up to three years under this solicitation. (Rare exceptions to this time limit may be allowed in suborbital investigations, where grants may be awarded for up to five years.) The actual amount of funding awarded to a particular program will be determined by the merit of the program and programmatic goals of the Office of Space Science.

Currently thirty-one investigations are being funded for detector development for a total of \$6.2M; sixteen for suborbital research for a total of \$4.1M, , and sixty-two in the remaining categories for a total of \$5.2M.

If at all possible, the participation of graduate students in the detector development and suborbital programs is strongly encouraged, especially if it can be concluded within the nominal tenure of graduate training. Therefore, brief details of the educational goals and training of such personnel should be included in the proposal.

2.2 Special Instructions for Multi-Institutional Proposals for Suborbital Program

Proposals to the suborbital program often involve the development of payloads that require collaboration among several institutions. In such cases, the lead PI may propose a direct subcontracting arrangement between the PI institution and the Co-I institutions, or alternatively in some cases it may be more appropriate for NASA to provide separate awards to each collaborating institution with an investigator from each Co-Investigator institution serving as the Institutional PI for the award to that institution (see Section 1.4 in the NASA Guidebook for Proposers). The following applies to proposals involving such separately funded contributions from multiple institutions.

- Only the primary proposal for the overall investigation, submitted by the single Principal Investigator, will be reviewed. This primary proposal must include the PI's work statement and budget, plus appended task statements and budgets from all other collaborating Co-I institutions. The Cover Page of the primary proposal must show separately the dollar amounts requested by the leading institution and each Co-I institution, plus the yearly total requests for the total investigation.

- The appended task statement(s) from Co-I collaborating institution(s), not to exceed five pages, must describe that institution's contribution to the investigation, the roles of the Co-I(s) at that institution (if more than one, a single investigator to serve as the Institutional PI for that institution must be identified), and a Budget Summary for the task following the formats specified in the NASA Guidebook for Proposers.
- Each Co-I institution must additionally submit a formal, signed proposal incorporating the task statement noted above, all prefatory materials indicated in the NASA Guidebook for Proposers, and a full institutional budget. Such Co-I proposals must be clearly cross-referenced on the Cover Page to the lead PI proposal and must have the same title as the PI proposal.

IMPORTANT INFORMATION

- As discussed in the *Summary of Solicitation* of this NRA, the Office of Space Science (OSS) now uses a unified set of instructions for the preparation and submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2003* (or *NASA Guidebook for Proposers* for short) that may be accessed by opening <http://research.hq.nasa.gov/> and linking through "Helpful References," or by direct access at <http://www.hq.nasa.gov/office/procurement/nraguidebook/> (note that the updated 2003-edition of the *Guidebook* is used for this solicitation).
- Section 6 of this NRA's *Summary of Solicitation* contains the Web address relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's *Cover Page/Proposal Summary/Budget Summary*, as well as the mailing address for the submission of the hard copies of a proposal.

Questions about the APRA program may be directed to the relevant Program Officers listed below with their areas of expertise. If uncertain, contact the APRA Lead Program Scientist. All Astronomy and Physics Division program scientists share the common mail address:

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Code SZ
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